# COMPREHENSIVE REPORT TO CONGRESS
# CLEAN COAL TECHNOLOGY PROGRAM

# CLEAN POWER FROM INTEGRATED COAL/ORE REDUCTION (CPICOR™) DEMONSTRATION PROJECT

**A Project Proposed by:**
**CPICOR™ Management Company, L.L.C.**

**June 1996**

**U.S. Department of Energy**
**Assistant Secretary for Fossil Energy**
**Office of Clean Coal Technology**
**Washington, D.C. 20585**

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# 1.0 EXECUTIVE SUMMARY

Public Law 102-154 provides funds to the Department of Energy (DOE) to conduct cost-shared Clean Coal Technology (CCT) projects for the design, construction and operation of facilities that: "...shall advance significantly the efficiency and environmental performance of coal-using technologies and be applicable to either new or existing facilities..." This Act, together with Public Law 101-512, made available a total of $600 million for a fifth general request for proposals under the Clean Coal Technology Program (CCT V). To that end, a Program Opportunity Notice (PON) was issued by DOE in July 1992.

In response to the PON, 24 proposals were received by DOE on December 7, 1992. After evaluation, five projects were selected for award. These projects use technologies that significantly advance efficiency and environmental performance and are applicable to either new or existing facilities.

One of the five projects selected for funding is a project to be headed by the CPICOR ™ Management Company, a limited liability company (L.L.C.) composed of subsidiaries of Centerior Energy Corporation, Air Products and Chemicals, Inc., and the Geneva Steel Company. The CPICOR ™ Management Company, which will be referred to as the Participant, has requested financial assistance from DOE for the design, construction and operation of a process that will integrate the production of liquid iron for steel making with the production of electricity for utility distribution. The project, named the Clean Power from Integrated Coal/Ore Reduction (CPICOR ™) Project, is to be located at Geneva Steel's plant in Vineyard, Utah (Figure 1). As originally proposed, the project was to be located in Cleveland, Ohio, within the LTV Steel Cleveland Works. However, the LTV Steel Company later withdrew from the project due to economic and other reasons, and the Geneva Steel Company agreed to replace LTV as a project team member and to host the CPICOR ™ Project in Vineyard, Utah. The project, including the demonstration phase, will last 76 months at a total cost of $1,065,805,000. DOE's share of the project cost will be 14 percent, or $149,469,242.

The proposed project will demonstrate the integration of the COREX® iron-making technology with combined cycle power generation to produce 3300 tons per day (tpd) of hot metal and 195 MWe of electricity. The COREX® technology, consisting of a melter-pyrolyzer connected to a reduction shaft, is a process of iron ore reduction in which the reducing gas comes directly from coal pyrolysis; hence, unlike blast furnaces, there is no need for coke ovens. The process has inherent environmental advantages over conventional blast furnace technology. When the COREX® offgas is used to fuel a combined cycle power plant, the

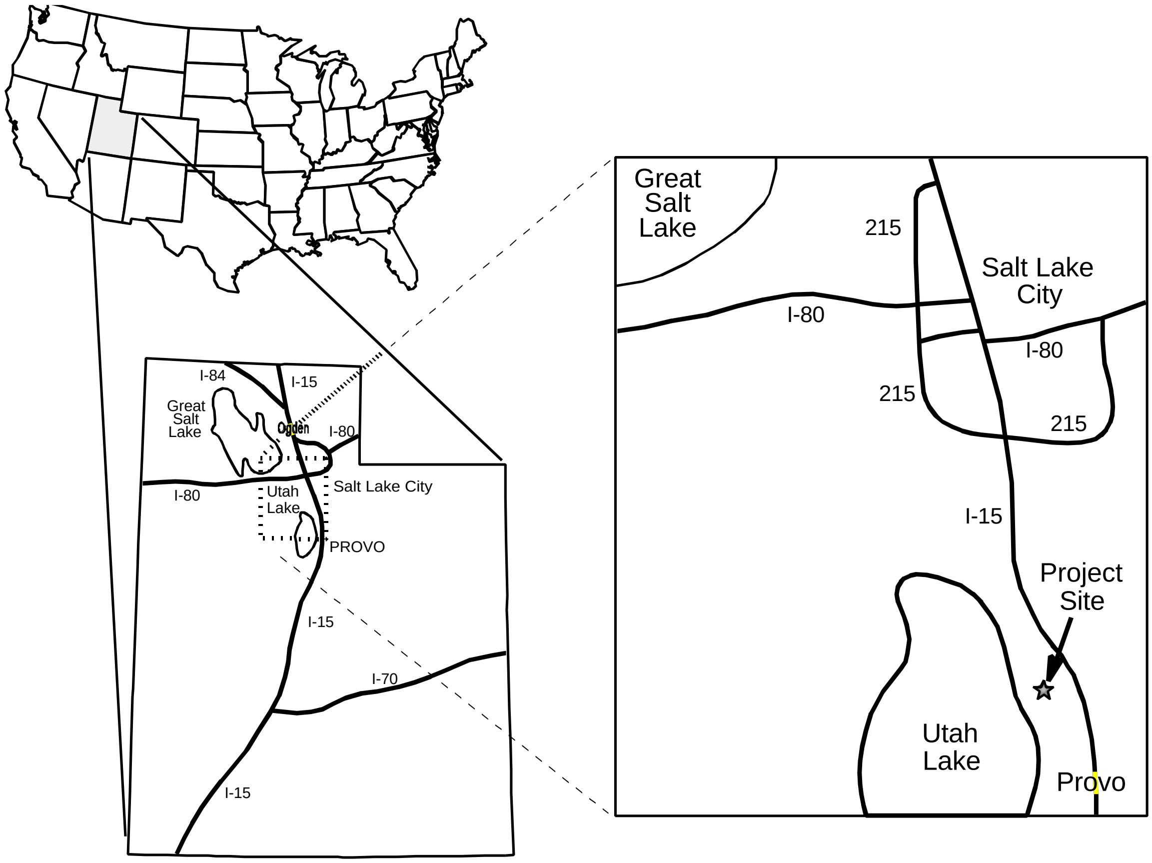



**Figure 1. CPICOR Project Location**

result is a process that is cleaner and more efficient than conventional technology.

The combined cycle power generation section of the CPICOR™ plant includes a 149 MWe combustion turbine, a heat recovery steam generator and a 122 MWe steam turbine. Energy consumption, including 36 MWe required by an air separation unit (ASU), 31 MWe for export gas compression and COREX® process requirements, and 9 MWe for combined cycle power generation auxiliary equipment, reduce the net power output to about 195 MWe. The CPICOR™ Plant will include a wet scrubber system to remove particulates from the COREX® unit's product gas. This combined cycle system also has significant environmental benefits over conventional coal-based power generation technologies.

The potential market for CPICOR™ technology includes the approximately 60 blast furnaces currently operating in the U.S. Replacing these blast furnaces with cleaner, more efficient technology would enhance the competitiveness of the domestic steel industry.

# 2.0 INTRODUCTION AND BACKGROUND

## 2.1 REQUIREMENT FOR A REPORT TO CONGRESS

The purpose of this Comprehensive Report is to comply with Public Law 102-154 which directs the Department of Energy to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-V Program.

On November 13, 1991, Public Law 102-154, the Department of the Interior and Related Agencies Appropriations Act, 1992 (Act), was signed into law. This Act, among other things, provided funds to DOE to conduct cost-shared Clean Coal Technology Projects for design, construction, and operation of facilities that "...shall advance significantly the efficiency and environmental performance of coal-using technologies and be applicable to either new or existing facilities..." This Act directed DOE to issue the fifth solicitation of the CCT Program no later than July 6, 1992, and specified that selection of Projects for negotiations shall take place "...not later that ten months after the issuance date for the fifth general request for proposals."

The Act, together with Public Law 101-512, made available a total of $600 million for the fifth general request for Proposals under the Clean Coal Technology Program. Of these funds, $7.2 million were required to be reprogrammed for the Small Business and Innovative Research Program and $25.0 million were designated for the Program Direction funds for costs incurred by DOE for implementation of the CCT-V Program. All of the remaining appropriated funds, $567.8 million, were available for award under the CCT-V PON.

## 2.2 EVALUATION AND SELECTION PROCESS

DOE issued a draft PON for public comment on April 20, 1992, receiving a total of 42 responses from the public. The final PON was issued on July 6, 1992, and took into consideration the public comments on the draft PON. On December 7, 1992, DOE received 24 proposals in response to the CCT-V solicitation. A Comprehensive Report on the proposals received in response to the CCT V PON was submitted to Congress in June 1993.

### 2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-V solicitation was to obtain "proposals to conduct cost-shared Demonstration Projects that advance significantly the efficiency and environmental performance of coal using technologies that are applicable to either new or existing facilities."

### 2.2.2 Qualification Review

The PON established seven Qualification Criteria and provided that, "In order to be considered in the Preliminary Evaluation Phase, a proposal must successfully pass Qualification." The Qualification Criteria were as follows:

(a) The proposed Demonstration Facility must be located in the United States.

(b) The proposed Demonstration Facility must be designed for and operated with coal. These coals must be from mines located in the United States.

(c) The Proposer must agree to provide a cost share of at least 50 percent of total allowable Project cost, with at least 50 percent in each of the Budget Periods.

(d) The Proposer must have access to, and use of, the proposed site of the Demonstration Facility and any proposed alternate site for the duration of the Demonstration Project.

(e) The proposed Project Team must be identified and firmly committed to fulfilling its proposed role in the Project.

(f) The Proposer agrees that, if selected, it will submit a "Repayment Agreement" consistent with Section 7.7.

(g) The Proposal must be signed by a responsible official of the proposing organization authorized to contractually bind the organization to the performance of the Cooperative Agreement in its entirety.

### 2.2.3 Preliminary Evaluation

The PON provided that a Preliminary Evaluation would be performed on all proposals that successfully passed the Qualification Review. In order to be considered in the Comprehensive

Evaluation phase, a proposal must be consistent with the stated objectives of the PON, and must contain sufficient finance, management, technical, cost, and other information to permit the Comprehensive Evaluation described in the solicitation to be performed.

### 2.2.4 Comprehensive Evaluation

The Technical Evaluation Criteria were divided into two major categories: (1) the Demonstration Project Factors were used to assess the technical and environmental merit of the project and the technical and management approaches to execute the project, and (2) the Commercialization Factors were used to assess the potential of the proposed technology to significantly improve environmental performance and efficiency in new or existing facilities and to achieve wide commercial acceptance.

The Cost and Finance Evaluation criteria were used to determine the business performance potential and commitment of the proposer.

The PON provided that the Cost Estimate would be evaluated to determine the reasonableness of the proposed cost. Proposers were advised that the Cost and Finance Evaluation Criteria were of least importance to the selection, and that successful proposers would be required to submit a more detailed cost estimate after selection and before award. Proposers were cautioned that if the total project cost estimate after selection was greater than the amount specified in the proposal, DOE would be under no obligation to increase the amount of funding above that which was requested in the proposal.

### 2.2.5 Program Policy Factors

The PON advised proposers that the following Program Policy Factors would be considered by the Source Selection Official to select a range of projects that would best serve program objectives:

(a) The desirability of selecting projects that collectively represent a diversity of methods, technical approaches, and applications.

(b) The desirability of selecting projects that collectively utilize a broad range of U.S. coals and are in locations which represent a diversity of EHSS, regulatory, and climatic conditions.

The word "collectively" as used in the foregoing program policy factors, was defined to include projects selected in this solicitation and prior clean coal solicitations, as well as other ongoing demonstrations in the United States.

### 2.2.6 Other Considerations

The PON provided that in making selections, DOE would consider giving preference to projects located in states for which the rate-making bodies of those states treat the Clean Coal Technologies the same as pollution control projects or technologies. This consideration could be used as a tie breaker if, after application of the evaluation criteria and the program policy factors, two projects receive identical evaluation scores and remain essentially equal in value. This consideration would not be applied if, in doing so, the regional geographic distribution of the projects selected would be altered significantly.

### 2.2.7 National Environmental Policy Act (NEPA) Compliance

As part of the evaluation and selection process, the Clean Coal Technology Program developed a procedure for compliance with the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality NEPA regulations (40 CFR Parts 1500-1508), and the DOE regulations for compliance with NEPA (10 CFR 1021). DOE's final NEPA regulations were published in the Federal Register on April 24, 1992 (57 FR 15122). The DOE procedure for NEPA compliance included the publication and consideration of a publicly available Final Programmatic Environmental Impact Statement (DOE/EIS-0146) issued November 1989, and the preparation of confidential pre-selection project-specific environmental reviews for internal DOE use. DOE also prepares publicly available site-specific documents for each selected demonstration project as appropriate under NEPA. The schedule for the CPICOR ™ Project allows 18 months for Budget Period 1 should an Environmental Impact Statement be required.

### 2.2.8 Selection

After considering the evaluation criteria, the program policy factors, and the NEPA procedure as stated in the PON, the Source Selection Official selected five projects as best furthering the objectives of the CCT-V PON. These selections were announced on May 4, 1993, during a press conference.

The project was originally proposed by Centerior Energy Corporation with team members of LTV Steel Company, Deutsche Voest-Alpine Industrieanlagenbau (DVAI), Air Products and

Chemicals, Inc., and Electric Power Research Institute (EPRI). During negotiations, LTV Steel Company, the host for the project site in Cleveland, Ohio, withdrew from the project. This resulted in the project being relocated to Vineyard, Utah, with Geneva Steel replacing LTV Steel Company as the team member for hosting the project site. During negotiations, the Source Selection Official determined that this change to the project would not have affected the original selection.

## 3.0 TECHNICAL FEATURES

### 3.1 PROJECT DESCRIPTION

The CPICOR™ Project will demonstrate an integrated new technology that produces both hot metal for use in steel making and clean electric power for utility distribution. The plant will be located at Geneva Steel's Vineyard, Utah plant. The backbone of the CPICOR™ project is the innovative process known as COREX® (Coal/Ore Reduction), in which molten iron is produced by continuous reduction and smelting of iron ore in two integrated unit operations -- a shaft furnace and a melter-pyrolyzer. A nominal 3300 tpd of hot metal will be produced, while the clean, medium BTU (220-225 BTU/SCF) export gas generated in the process will be used to fuel a combined cycle power generation facility producing 195 MWe of net export power. In addition to the COREX® unit, which will produce hot metal and the medium BTU export gas, the plant will include a gas cleaning section to remove particulate from the export gas; a combustion turbine; an air separation unit to provide oxygen to the melter pyrolyzer; a heat recovery steam generator; a steam turbine generator set; and all necessary auxiliary systems.

The CPICOR™ technology is less complex and environmentally superior to competing iron-making and power generation technology. Because the COREX® process replaces the conventional coke oven plant and blast furnace normally used in virgin hot metal production with a single integrated operation, the hazardous air emissions associated with coke ovens are avoided. The reducing atmosphere in the melter minimizes the formation of $NO_x$ compounds. Desulfurization is an inherent part of the COREX® process. As the reducing gas rises from the melter into the reduction shaft furnace, most of the sulfur is bound by the calcined limestone/dolomite additives descending through the shaft furnace. A conceptual flow diagram of the CPICOR™ plant is presented in Figure 2.

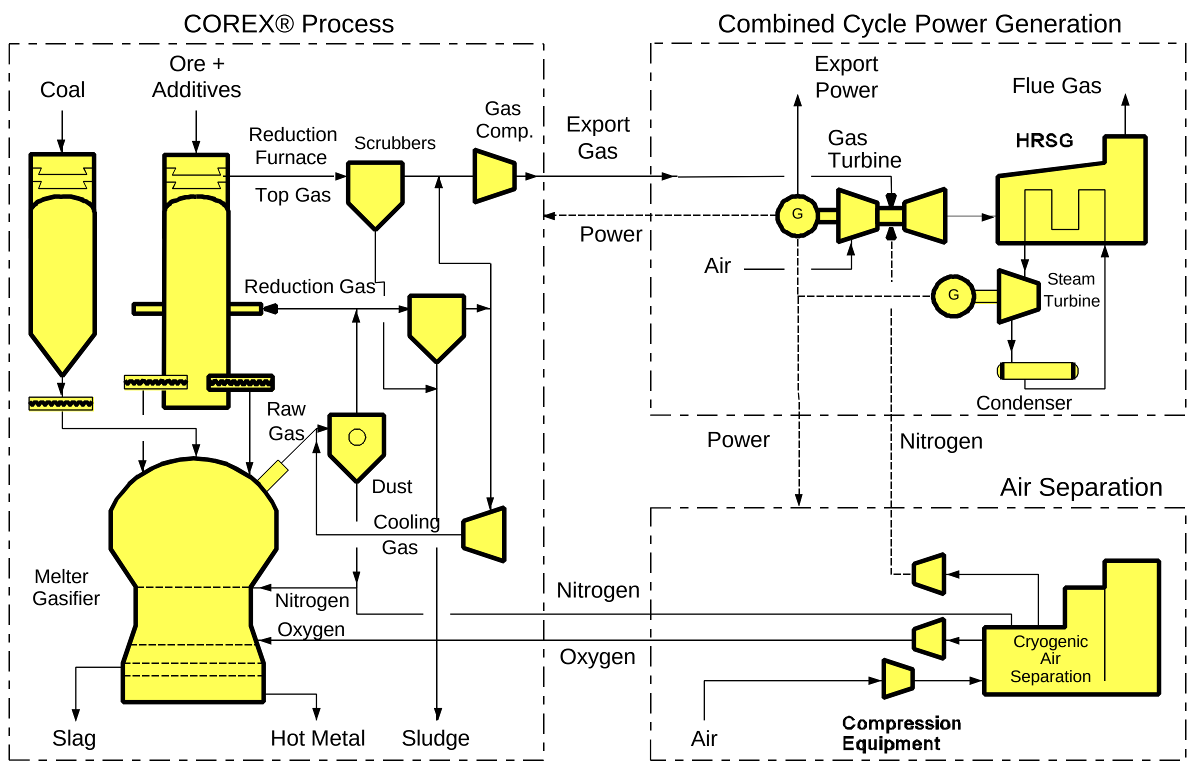



**Figure 2. Conceptual Flow Diagram**

Particulate removal is accomplished with a wet scrubbing system. Air emissions from the COREX® technology, compared to conventional iron-making technology, are shown in Table 1 (source: DVAI).

Table 1. Air Emissions from COREX® and Conventional Iron-making Process (pounds per ton of hot metal)

| Air Emissions | Conventional | COREX® Process |
|---|---|---|
| sulfur dioxide | 6.6 | 0.5 |
| nitrogen oxides | 2.4 | 0.046 |
| particulates | 4.2 | 0.036 |

The energy efficiency of the CPICOR™ plant is over 35% greater than competing commercial technology when consideration is given to the production of both hot metal and electric power. The thermal efficiency of the COREX® process is 9% higher than the conventional coke oven/blast furnace route. The higher efficiency of COREX® is primarily attributable to its single self contained process, which effectively retains and uses the heat generated. In the conventional two-staged coke plant/blast furnace route, the heat contained in the hot coke is lost in quenching. In addition, combined cycle power generation achieves energy efficiencies of greater than 40% compared to a maximum of 34% with conventional, state-of-the-art, coal-based power systems with flue gas sulfur dioxide ($SO_2$) scrubbing --- a 17% improvement.

In addition to the environmental and efficiency advantages described above, CPICOR's iron-making technology has the advantage of being able to operate on a much broader spectrum of available coals than conventional iron-making technology, including non-coking coals.

Project activities include engineering and design, permitting, procurement, construction, start up, and demonstration. At least 85% of pre-operation costs will be expended for materials and services manufactured or provided domestically. During the 29-month demonstration phase, the CPICOR™ plant will be operated on several types of coal, thus enhancing future viability of the technology. Most importantly, this demonstration would, for the first time, accomplish the successful integration of an advanced iron-making process with efficient generation of electricity in an adjacent combined cycle power plant. Hence, the CPICOR™ project is expected to foster the commercialization of iron-making and power generation technologies which are both cleaner and more efficient than conventional technologies.

### 3.1.1 Project Summary

| | |
|---|---|
| Title: | Clean Power from Integrated Coal/Ore Reduction -- CPICOR™ |
| Proposer: | CPICOR™ Management Company, L.L.C. |
| Location: | Geneva Steel Company's steel mill in Vineyard, Utah County, Utah |
| Technologies: | COREX® iron-making process, cryogenic air separation unit, combined cycle power generation system. |
| Applications: | metallurgical and power generation |
| Type of Coal Used: | Western bituminous coal |

| | |
|---|---|
| Products: | Molten iron and electric power |
| Project Size: | 3,300 tpd of hot metal plus 195-MWe (net) electricity generation using inputs of 3,400 tpd of coal and 5,800 tpd of iron ore and additives |
| Project Start Date: | September 1996 |
| Project End Date: | January 2003 |

#### 3.1.2 Project Sponsorship and Cost

| | | |
|---|---|---|
| Project Sponsor: | CPICOR™ Management Company, L.L.C. | |
| Project Co-Funders: | Geneva Steel Company, Air Products and Chemicals, Centerior Energy Corporation, and U.S. Department of Energy | |
| Estimated Project Cost: | $1,065,805,000 | |
| Cost Distribution: | Participant Share | $916,335,758 |
| | DOE Share | $149,469,242 |

### 3.2 CPICOR™ PROCESS

#### 3.2.1 Overview of Process Development

The CPICOR™ Project integrates combined cycle power generation with the COREX® process of coal pyrolysis and hot metal production--a method that avoids the production and use of conventional coke and metallurgical coal and their associated environmental and economic impacts. The Project will use data from the successful demonstration of COREX® plants operated in South Africa and South Korea. These plants will provide a guide to address modest technical issues. The South African plant, located in Pretoria, has operated successfully since 1989, producing 1000 metric tpd of hot metal. The 2000 metric tpd South Korean plant, located in Pohang, started operation in 1995. In addition a pilot plant, located in Germany, provided 6000 hours of operating experience between 1981 and 1987. Technical risk for the CPICOR™ Project is considered low as the issues are ones of integration and interconnection. The Project will basically demonstrate an integrated new technology that produces both hot metal for use in steel making and clean electric power for utility distribution. The Project will integrate a 3000 metric ton per day COREX® plant with commercial air separation and combined cycle technologies for the production of liquid iron metal and 195 MWe electricity.

The DOE, through the Clean Coal Technology program, supports the development of advanced power generation technologies that are cleaner and more efficient than conventional technologies. Combined cycle power generation, with its inherent efficiency advantage, has been successfully integrated with numerous fuel processing technologies. The DOE continues to support demonstration projects that advance the economic and environmental performance, as well as the reliability, of combined cycle systems. The CPICOR™ Project will contribute significantly to this effort. In addition the Project represents an opportunity to foster the commercialization of an iron-making process that is environmentally superior to conventional coke oven/blast furnace integrated steel-making technologies. It would also enhance the competitiveness of the U.S. steel industry which is subject to increasingly stringent environmental regulations. DOE also notes that it has received more than 30 letters of support from the iron, steel, coal and engineering segments of the industry for this project; this indicates a strong likelihood of commercial acceptance of the COREX® technology once a successful demonstration is complete.

### 3.2.2 Process Description

The three major components of the CPICOR™ demonstration project (Fig. 2) are the COREX® unit, the ASU, and the combined cycle power plant. The COREX® unit consists of a melter-pyrolyzer and a reduction shaft furnace. The iron ore, along with required additives, is introduced into the top of the reduction shaft and flows by gravity toward the bottom, from which it is moved to the top of the melter-pyrolyzer by screw conveyors. Coal is introduced directly by screw conveyors into the top of the melter and oxygen from the ASU is introduced through nozzles, called tuyeres, around the circumference of the melter. Upon entering the top of the melter, the coal is dried and devolatilized at temperatures exceeding 1900þF before being partially combusted in the lower part of the melter, where the temperature reaches 3000þF. These reactions produce a reducing offgas with an energy content of 220-225 BTU/SCF. After passing through a dust separation cyclone, a portion of this product gas enters the bottom of the reduction shaft. From there, the gas ascends the reduction shaft, flowing counter-current to the descending iron ore and limestone/dolomite additives.

In the reduction shaft, operating at 1550þF, the iron ore is partially reduced to metallic iron, while the sulfur contained in the gas is retained by the highly reactive limestone/dolomite additives.

The direct-reduced iron (DRI) and additives are further reduced in the melter to form liquid hot metal and slag, which are collected at the bottom of the melter unit. The separation of hot metal from slag is effected by the difference in densities as practiced in a conventional blast furnace. The liquid iron will be utilized directly by Geneva's adjacent steel works, and the slag has potential for sale into an existing market for purposes such as basic building material for roads.

Along with the balance of the product gas from the melter, the desulfurized gas exiting the reduction shaft is sent to a scrubber section to remove particulates. It is then converted to a very clean, pressurized export gas suitable for use in a combustion turbine (CT). The gas is expanded in the CT which drives an electric generator, producing 149 MWe of electric power. A portion of the nitrogen produced by the cryogenic separation process may be directed to the CT and injected into the combustor section in order to increase the gas turbine shaft power output.

The CT exhaust gas flows through a heat recovery steam generator (HRSG) where its waste heat is used to generate steam; the steam generated in the HRSG is then expanded in a steam turbine to produce an additional 122 MWe of electric power. Energy sinks, including the ASU (36 MWe), export gas compression and COREX® Unit requirements (31 MWe), and plant auxiliaries (9 MWe), reduce the net power output to about 195 MWe.

## 3.3 GENERAL FEATURES OF PROJECT

### 3.3.1 Evaluation of Developmental Risk

After selection of this project, DOE performed a detailed evaluation of the CPICOR™ Project and determined it to be reasonable and appropriate. The evaluation focused on the project's technical, schedule, and cost risks. A team of experts, both within DOE and available under contract, contributed to the evaluation. The data base for the evaluation included Participant-furnished documentation and fact-finding discussions with the Participant.

The primary technical risk associated with this project lies in the integration of the COREX® Process with an ASU and a combined cycle power generation system. The CPICOR™ Project will employ a 3,300 tpd (3,000 metric tpd) unit whose internal dimensions are not significantly different from those of the unit in South

Korea. The only difference is a slightly increased feed rate into a similar sized plant. CPICOR ™'s schedule is such that much experience will be gained from the South Korean unit; hence, the technical risks in the present Project are considered minimal. Other COREX ® equipment, such as the screw-feeders, scrubbers, and cyclones, are proven designs in use at various plants, and present low risk. They will be used in multiples as required. The remaining components of the CPICOR ™ Project, i.e., the ASU, the combined cycle power plant, and the power grid interface, are based on well-established technologies and thus present a very low level of technical risk. An adequate technical database exists to ensure success of the demonstration. The integration and interconnection of the three major systems for efficient and safe operation will be the key focus of the Project.

The 76-month schedule, presented in Section 6.2, allows sufficient time for the design, construction and operation of the demonstration project. The most critical items affecting the schedule are National Environmental Policy Act (NEPA) requirements, permitting, and construction delays. The project schedule allows 18 months for completion of NEPA and a Record of Decision, should an EIS be needed. The Project Team has provided ample time in the schedule to resolve any environmental concerns and will obtain delivery guarantees for critical equipment items, thus mitigating any potential schedule problems. The schedule allows 23 months to complete engineering, permitting, and a definitive estimate. Phase II (detailed design, procurement, construction and start-up) begins 5 months before the completion of Phase I to allow for early vendor engineering of long-lead time equipment, such as the gas turbine. Finally, the planned 29-month demonstration period will allow for demonstration of the process performance, system availability, and reliability.

The cost estimates for the ASU, combined cycle power generation, and power grid portions of the project are well-founded in the experience database of the Project Team members. The cost estimates for the COREX ® system are not as firmly based because no prior COREX ® system of the proposed capacity has been constructed. The COREX ® estimates, of necessity, are less accurate than those for the other portions of the project. The estimating method used, however, is reasonable. The estimated amounts present a low to moderate risk of cost overrun.

DOE recognizes that demonstrating the commercial readiness of new technologies inherently carries a certain amount of risk. Careful assessment of the risks associated with this project, coupled with the potential benefits of the technology, lead DOE to conclude that those risks are acceptable and worth taking.

#### 3.3.1.1 Similarity of Project to Other Demonstration and Commercial Efforts

The COREX® iron-making process is being commercially demonstrated at 1000 metric tpd at ISCOR's Pretoria Works in South Africa and at 2000 metric tpd in Pohang, South Korea. The primary advances incorporated in the CPICOR ™ Project are the integration of the COREX® process with commercial air separation and combined cycle power generation technologies.

The CPICOR ™ project represents the first attempt to integrate combined cycle power generation with the COREX® iron-making process. Combined cycle power generation has already been successfully integrated with coal derived gases; the DOE, through the Clean Coal Technology Program, continues to support demonstration projects which advance the state-of-the-art in the environmental and economic performance, as well as the reliability, of combined cycle technologies. This project provides an opportunity to demonstrate advances in an environmentally superior iron-making technology and to demonstrate a novel integration of valuable excess export gases for clean power generation.

#### 3.3.1.2 Technical Feasibility

As discussed in Section 3.3.1, DOE recognizes that technical uncertainties exist in the proposed project. However, overall, the project is technically sound and reasonable.

The COREX® process has been shown to be technically sound through on-going commercial plants. The primary uncertainties relate to the effect of the somewhat higher feed rate on the relative sizes of the "fixed" and "fluidized" zones of the melter. Much of the auxiliary equipment for the COREX® reactor is similar in design to that currently in use. The ASU and the components making up the combined cycle power plant are commercially available technologies.

#### 3.3.1.3 Resource Availability

The project will be located at Geneva Steel's site in Vineyard Utah. All essential infrastructure services are available, including water, natural gas, rail and highway access, electric service, and sanitary waste disposal. Resources for lifetime operation of the project (including manpower, land, coal and limestone) are available in the region.

The partners of the CPICOR ™ Management Company, through their parent companies, have arranged to provide the Participant's share of the project financing for the first Budget Period as presented in Section 6.1. The Participant will reach financial closure for his share of remaining project costs by the end of the first Budget Period.

### 3.3.2 Relationship Between Project Size and Projected Scale of Commercial Facility

The project would demonstrate a commercial-size unit producing 3,300 tpd (3000 metric tpd) of hot metal and 195 MWe net electric power. No further scale-up of the COREX® unit is required for the demonstrated technology to become commercially attractive. All technical, economic, and environmental data from the project will be directly applicable to commercial projects. The size is based on existing domestic blast furnaces, since these represent the potential market for CPICOR™ technology. The COREX® unit operated by ISCOR (1000 tpd) is large enough to replace 1 of the 60 blast furnaces currently operating in the U.S.; the unit in Pohang, South Korea (2000 tpd) is large enough to replace about 15% of existing domestic blast furnaces. CPICOR™'s size is key to rapid commercialization of COREX®, since it would be large enough to replace 65% of existing blast furnaces.

### 3.3.3 Role of Project in Achieving Commercial Feasibility of Technology

The CPICOR™ demonstration project would provide the design, construction and operating data crucial to commercializing the COREX® and CPICOR™ technology. This technology has inherent advantages over conventional blast furnace technology. The COREX® unit, by performing the functions of both a coke oven and a blast furnace, makes more effective use of sensible heat while achieving reduced pollutant emissions (especially hazardous air pollutants). When integrated with a combined cycle power plant, the result is a cleaner and more efficient process that provides molten iron for steel production and electricity for utility distribution.

The project is expected to begin operation in 2000. Verification of the commercial feasibility of the technology would be accomplished with a 29-month test program, after which the project will continue to operate as part of Geneva Steel's commercial plant. As previously stated, the technology offers several advantages which contribute to its marketability:

þ By combining hot metal production with electricity generation, the integrated CPICOR™ Technology makes more effective use of the available energy in coal and, hence, achieves higher efficiencies than possible with conventional blast furnace technology; i.e., the utilization of total energy in the coal is maximized.

þ The integrated CPICOR ™ Technology has the capability of using a wide variety of coals, including non-coking coals.

þ The integrated CPICOR ™ Technology provides superior environmental performance which will satisfy current and future regulations.

þ The integrated CPICOR ™ Technology's target market for commercialization is the aging domestic integrated coke ovens/blast furnace population; hence market penetration is likely to be high if the Participant's economic, efficiency, reliability and environmental performance targets are met.

þ The integrated CPICOR ™ Technology also targets the market for virgin iron needed by the steel industry's non-integrated mini-mills that use electric arc furnace technology.

## 4.0 ENVIRONMENTAL CONSIDERATIONS

The overall procedure for compliance with NEPA, cited in Section 2.2.7, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a pre-selection, project-specific environmental analysis; and a post-selection, site-specific environmental analysis. To satisfy the first element, DOE issued the final PEIS to the public in November 1989 (DOE/EIS-0146). In the PEIS, results derived from the Regional Emissions Database and Evaluation System (REDES) were used to estimate the environmental impacts that might occur by the year 2010 if each technology were to reach full commercialization and capture 100 percent of its applicable market. The environmental impacts were compared to the no-action alternative, which assumed continued use of conventional coal technologies through 2010, with new plants using conventional flue gas desulfurization to meet New Source Performance Standards (NSPS).

The second element of DOE's NEPA procedure for the CCT Program involved preparation of a pre-selection environmental review based on project-specific environmental data and analyses that offerors supplied as part of their proposals. The review summarized the strengths and weaknesses of each proposal against the environmental evaluation criteria. It included, to the extent possible, a discussion of alternative sites and processes reasonably available to the offeror, practical mitigating measures such as the options for controlling discharges and for management of solid and liquid wastes, impacts of each proposed demonstration on the local environment, and a list of required permits. Finally, the risks and impacts of each proposed project were assessed. This analysis was provided for the Source Selection Official's use before the selection of proposals.

When compared to conventional iron-making technology, the COREX® process is more environmentally benign, eliminating the air, water, and solid waste discharges associated with coke making. This significantly reduces the emissions, effluents and wastes per unit of iron produced. The gas produced by the COREX® unit contains no measurable sulfur dioxide or nitrogen oxides. Sulfur will be removed by the limestone flux added to the COREX® unit and exit with the slag. The inert, nonleachable, nonhazardous slag is readily salable as construction aggregate material and rock wool. Particulates are removed from the product gas with conventional cyclones and wet scrubbers.

As the final element of the NEPA procedure, the Participant will submit to the DOE the environmental information specified in Appendix J of the PON. This detailed site-specific and project-specific information will be used as the basis for the site-specific NEPA documents to be prepared by DOE. These documents, which will be in full compliance with NEPA, CEQ and the DOE regulations for NEPA compliance, must be completed and approved before federal funds are provided for any activity that would limit the choice of reasonable alternatives to the proposed action or have an adverse environmental impact.

In addition to the NEPA requirements outlined above, the Participant must prepare and submit an Environmental Monitoring Plan (EMP) for the project, following the guidelines provided in Appendix N of the PON. The purpose of the EMP is to ensure that sufficient technology, project, and site environmental data are collected to provide health, safety, and environmental information for use in subsequent commercial applications of the technology.

The Participant will be required to describe, in an Environmental Information Volume, impacts to the environment which include overall reductions in sulfur dioxide, nitrogen oxides and carbon monoxide emissions from those that would occur assuming the application of NSPS. The Participant will also prepare an Environmental Incident Likelihood Assessment during budget period 1 which examines the overall risks of an environmental incident and their ability to mitigate and/or correct the same with full indemnification of the Government.

## 5.0 PROJECT MANAGEMENT

### 5.1 OVERVIEW OF MANAGEMENT ORGANIZATION

The CPICOR ™ Demonstration Project organization is shown in Figure 3. The members in the CPICOR ™ Management Company, L.L.C are subsidiaries of Centerior Energy Corporation, Air Products and Chemicals, Inc. (APCI) and the Geneva Steel Company. The CPICOR™ Management Company will be responsible for executing all aspects of the Cooperative and Repayment Agreements. Along with members of the CPICOR ™ Management Company (CMC), the project team includes Deutsche Voest-Alpine Industrieanlagenbau GmbH (DVAI). DVAI, and its parent, Voest-Alpine Industrieanlagenbau GmbH (VAI), jointly own the rights to the COREX ® process. VAI has guaranteed the performance and obligations of DVAI under the Cooperative Agreement and Repayment Agreement. DVAI will provide the design for the COREX ® portion of the project and some of the equipment. In addition, DVAI will be primarily responsible for commercialization of the COREX ® technology in the United States and providing repayment through CMC.

Geneva Steel Company will establish a wholly-owned subsidiary, Vineyard Iron Company, to participate in the CPICOR ™ Cooperative Agreement. Vineyard Iron Company will be responsible for the design and construction of the COREX ® facility and will enter into a licensing agreement with DVAI for the COREX ® technology. The Vineyard Iron Company will also be responsible for operation of the COREX ® facility and will sell hot metal to the Geneva Steel Company. Geneva Steel Company through Vineyard Iron Company will provide the project site and its partnership share of project funding for the first budget period.

Air Product and Chemicals, Inc. (APCI) will establish a subsidiary, the Utah Clean Coal Management Company (UCCMC), who will be a partner of the CPICOR ™ Management Company. APCI through UCCMC will provide its partnership share of project funding for the first budget period. In addition, APCI will market the CPICOR ™ technology in the U.S. and participate in repayment.

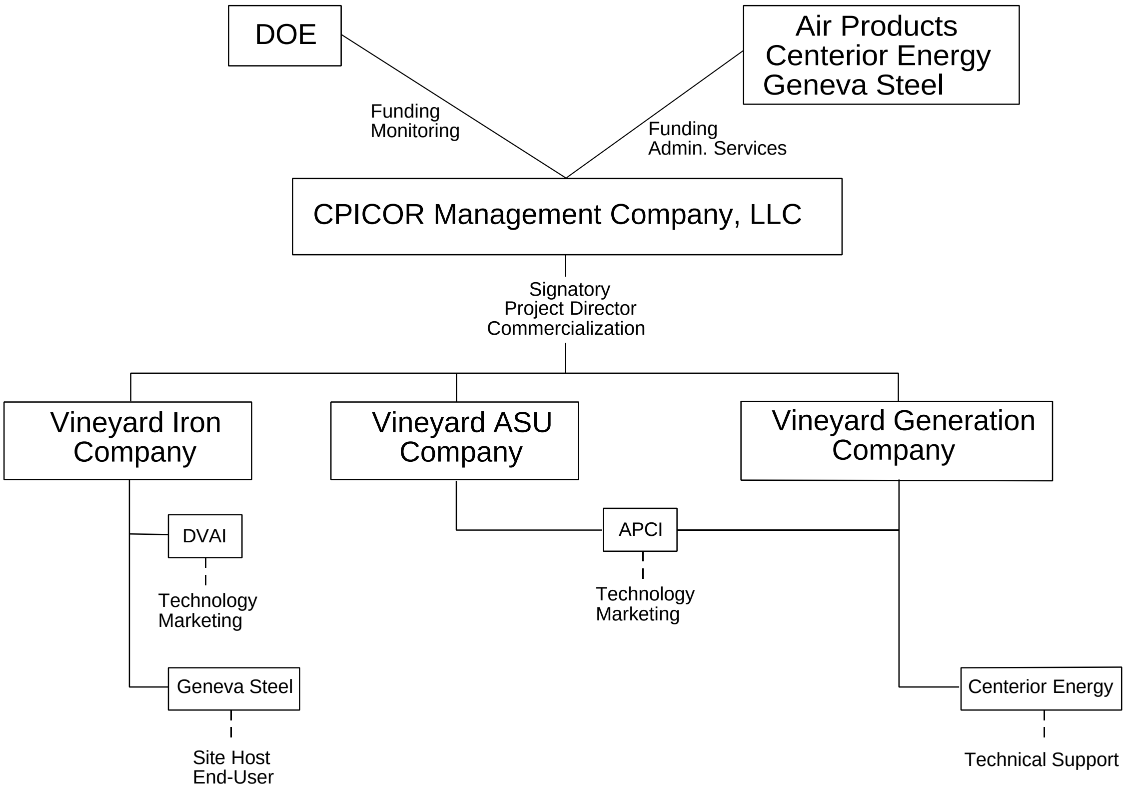



**Figure 3. CPICOR Project Team Structure**

Centerior Energy Corporation established an unregulated subsidiary, Centerior Power Enterprises, Inc., to participate in the CPICOR™ Project. Centerior Power Enterprises, Inc. and APCI's subsidiary, UCCMC, will establish the Vineyard Generation Company. Under contract with the CPICOR™ Management Company, the Vineyard Generation Company will be responsible for the design, construction and operation of the combined cycle power generation facility, including purchasing export gas from the COREX® facility and negotiating a power sales agreement. Centerior Energy Corporation through Centerior Power Enterprises, Inc. will provide its partnership share of project funding.

UCCMC and Centerior Power Enterprises will also establish the Vineyard ASU Company. The Vineyard ASU Company will sell oxygen and nitrogen to the Vineyard Iron Company. Vineyard ASU Company may also sell excess nitrogen to the Vineyard Generation Company for additional mass flow and subsequent power production.

## 5.2 IDENTIFICATION OF RESPECTIVE ROLES AND RESPONSIBILITIES

### 5.2.1 DOE

DOE will be responsible for monitoring all aspects of the project and for granting or denying approvals required by the Cooperative Agreement. A DOE Project Manager will be designated by the DOE Contracting Officer to act as a Contracting Officer's Representative. The Project Manager will be the primary point of contact for the project and will be responsible for DOE management of the project.

### 5.2.2 Participant

The CPICOR ™ Management Company, as the Participant, will be responsible for all aspects of the project, including design, permitting, construction, operation, data collection and reporting. The Participant will designate a full time Project Director, who will be responsible for all technical and administrative activities to be performed under the Cooperative Agreement. This Project Director will be the primary point of contact for DOE interaction.

## 5.3 PROJECT IMPLEMENTATION AND CONTROL PROCEDURES

The Participant will prepare and maintain a Project Management Plan that presents project procedures, controls, schedules, budgets, and other activities required to adequately manage the project. This document, which will be finalized shortly after execution of the Cooperative Agreement, will be used to implement and control project activities. Throughout the course of the project, reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared and delivered to DOE.

## 5.4 KEY AGREEMENTS IMPACTING DATA RIGHTS, PATENT WAIVERS, AND INFORMATION REPORTING

With respect to data rights, DOE has negotiated terms and conditions that will generally provide for rights of access by DOE to all data generated or used in the course of or under the Cooperative Agreement by the CPICOR ™ Management Company and its subcontractors. DOE will have unlimited rights to specified categories of data first produced in the performance of the Cooperative Agreement, rights to use and evaluate "protected" data and limited rights of access to proprietary data utilized in the course of the demonstration.

With regard to patents, data and other intellectual property, the Participant has made a contractual commitment to exercise its best efforts to commercialize the technology demonstrated in this project.  To effect commercialization, the Participant has also made a contractual commitment to flow down their commercialization obligation in all contracts with suppliers of the technology to be demonstrated under this Cooperative Agreement.

The Participant is expected to request for itself and on behalf of its subcontractors who will participate in the demonstration program, a waiver of patent rights in any subject invention, i.e., any invention or discovery by any of them which is conceived or first actually reduced to practice in the course of or under the Cooperative Agreement.  Favorable action is anticipated to be given to the Participant's Patent Waiver request considering the level of cost sharing, the commitment by its principal subcontractors to commercialization of the iron-making and power generating technologies, and agreement by the Participant to repay up to the Government's contribution in accordance with the DOE guidelines.  Any grant of a patent waiver will reserve to the Government a nonexclusive, nontransferable, and irrevocable paid-up license to practice or to have practiced any waived subject invention for or on behalf of the United States.

## 5.5 PROCEDURES FOR COMMERCIALIZATION OF TECHNOLOGY

The Participant's commercialization plan focuses on CPICOR Management Company and DVAI leading the commercialization of the CPICOR™ technology in the U.S.  Additionally, DVAI will actively market the COREX® Process in the U.S. with or without integration with power generation.

The CPICOR™ Project is a vital step towards commercialization of the COREX® technology and the integration of that technology with combined cycle power generation.  It is essential that a demonstration of the technology be conducted to establish long term reliability, availability, maintainability and environmental performance at a scale sufficient to illustrate commercial potential.  Following the demonstration period, Geneva Steel will continue to operate the CPICOR™ plant as part of its commercial facilities.  DOE's review of their plans and agreements concluded that the commercialization provisions provide a logical route for the introduction of COREX® technology into the U.S. and that all replications of the CPICOR™ and COREX® technologies in the U.S., of comparable size or larger than the demonstration unit, will be captured by the Repayment Agreement.

In the U.S. there are currently about 60 blast furnaces, all of which have been operating for more than 10 years (with some originally installed up to 90 years ago). These aging blast furnaces, as well as the coke ovens that fuel them, are subject to increasingly stringent environmental regulations. The COREX® technology represents an environmentally superior alternative for hot metal production that would replace the coke oven and the blast furnace with one continuous process. When the COREX® unit is joined with a combined cycle power generation plant, the result is a process that is more efficient, as well as cleaner, than conventional technology.

The commercialization of the CPICOR™ technology will contribute greatly to the growing domestic and international coal market by using cleaner, more efficient technologies, while reducing the U.S. dependence on foreign oil, coke, and raw iron. Replicating the CPICOR™ technology will also provide a significant number of additional jobs for U.S. workers. Besides jobs and the preservation of U.S. engineering, design and manufacturing capabilities, the U.S. will benefit by receiving increased taxes from employed workers and an enhanced trade position from equipment, steel and services export.

## 6.0 PROJECT COST AND EVENT SCHEDULING

### 6.1 PROJECT BASELINE COSTS

The estimated cost and the cost sharing for the work to be performed under the Cooperative Agreement are as shown below.

Pre-award Cost

| | | |
|---|---|---|
| DOE Share | $ 506,000 | 14.0% |
| Participant Share | $ 3,110,000 | 86.0% |
| | $ 3,616,000 | 100.0% |

Phase I

| | | |
|---|---|---|
| DOE Share | $ 37,560,000 | 50.0% |
| Participant Share | $ 37,560,000 | 50.0% |
| | $ 75,120,000 | 100.0% |

Phase II

| | | |
|---|---|---|
| DOE Share | $ 106,434,000 | 20.2% |
| Participant Share | $ 420,551,000 | 79.8% |
| | $ 526,985,000 | 100.0% |

Phase III

| | | |
|---|---|---|
| DOE Share | $ 4,969,242 | 1.1% |
| Participant Share | $ 455,114,758 | 98.9% |
| | $ 460,084,000 | 100.0% |

Total Estimated Project Cost

| | | |
|---|---|---|
| DOE Share | $ 149,469,242 | 14.0% |
| Participant Share | $ 916,335,758 | 86.0% |
| | $1,065,805,000 | 100.0% |

Sequential budget period costs, dependent upon scheduling of activities in the project phases, shall be shared by DOE and the Participant as shown below. At the beginning of each budget period, DOE intends to obligate sufficient funds to pay its share of the expenses for that period.

The Participant's funds for the first budget period have been committed to the project through the parent companies of Vineyard Iron Company, Centerior Power Enterprises and UCCMC. Financial closure for the remaining share of the Participant's funds to complete the project will be provided at the end of the first budget period.

Budget Period 1 *

| | | |
|---|---|---|
| DOE Share | $ 8,838,000 | 43.6% |
| Participant Share | $ 11,444,000 | 56.4% |

Budget Period 2

| | | |
|---|---|---|
| DOE Share | $ 135,662,000 | 23.2% |
| Participant Share | $ 449,777,000 | 76.8% |

Budget Period 3

| | | |
|---|---|---|
| DOE Share | $ 4,969,242 | 1.1% |
| Participant Share | $ 455,114,758 | 98.9% |

* Pre-award costs are included in Budget Period 1.

## 6.2 MILESTONE SCHEDULE

The project is divided into three phases and is expected to take 76 months to complete. The phases and their expected durations are as shown below:

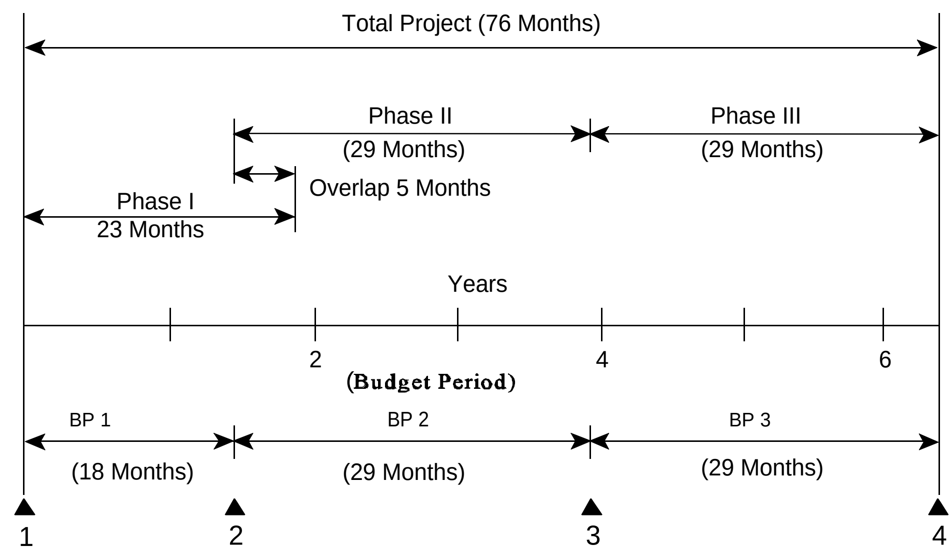
Phase I (23 months)
- design, permitting, and NEPA

Phase II (29 months)
- detailed design, procurement, construction and start-up

Phase III (29 months)
- operation and data collection

Phases I and II overlap by 5 months.

Budget periods are used to manage the financial risk of the project and to facilitate project decision making. A project schedule is shown in Figure 4.




| Milestone | Description |
|---|---|
| 1 | Project starts/DOE signs/EIV submitted |
| 2 | NEPA/definitive estimate completed |
| 3 | Construction/startup complete/operation begins |
| 4 | Testing completed |

**Figure 4. CPICOR Project Schedule**

Budget Period 1 (18 months):
- project definition, preliminary engineering, NEPA, all internal agreements, and full project financing

Budget Period 2 (29 months):
- detailed design, construction, and start-up

Budget Period 3 (29 months):
- operation and data collection

Construction is expected to be completed by July 2000, and the project is expected to be completed by December 2002.

## 6.3 REPAYMENT AGREEMENT

Based on DOE's recoupment policy as stated in Section 7.7 of the PON, DOE is to recover an amount up to the Government's contribution to the project. The Participant has agreed to pay the Government in accordance with the Repayment Agreement to be executed at the time of award of the Cooperative Agreement. Although, the Participant, CPICOR ™ Management Company, L.L.C. (CMC), is responsible to DOE for repayment, the repayment obligation will be flowed down to DVAI and Air Products. CMC will continue to manage the repayment obligation, accounting, and reporting.

The repayment obligation is based on revenues received by CMC, DVAI, or Air Products during the 20 year repayment period for the commercialization of the COREX ® Process and/or the CPICOR ™ technology in the United States. Sources for repayment are: (1) 5 percent of the DVAI license fee for the COREX ® technology (2) 1/2 percent of the price of the equipment sold by DVAI and embodied in a COREX ® facility (3) 1/2 percent of the project management, engineering and construction fees received by Air Products for future CCPG Plants that include the COREX ® technology and (4) supplemental revenue based on a percentage of the COREX ® export gas sold for power generation or other uses.